

# Volvo CE



# Volvo CE Sound and Vibration

## Presentation content

- Demands
- Test methods
- Sound and Vibration Reduction Strategy
- Working Methods
- Actions

## Sound and Vibration

### Exterior sound

Directive 2000/14/EC  
Blue Angel =>  
Sound Kit



### Interior sound

Directive 2003/10/EC <80 dBA  
Customer demands: <70 dBA and  
Sound Quality - Experience

### Vibration

Directive 2002/44/EC  
Whole-body and Hand-arm  
Operator Comfort

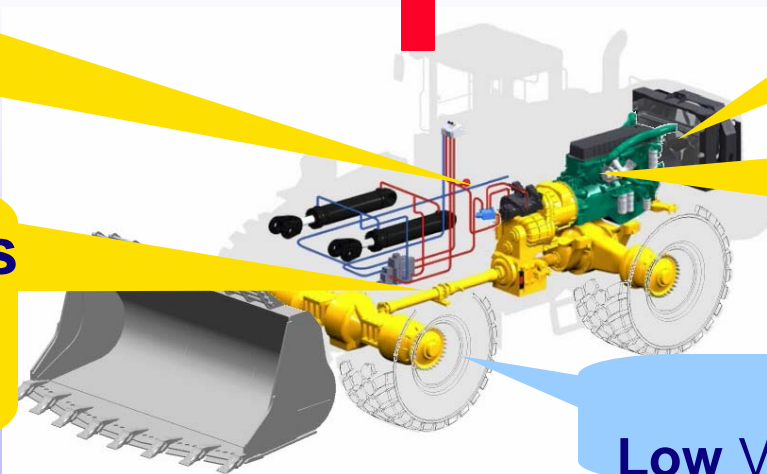
## Minimise sound and vibration transmission

### Hydraulic system

Pumps with low  
Ripple and  
Sound Levels

### Transmission / Axles

Gear Tooth Quality and  
Housing Design



### Cooling system

Efficient Coolers  
Low Noise Fan

### Engine

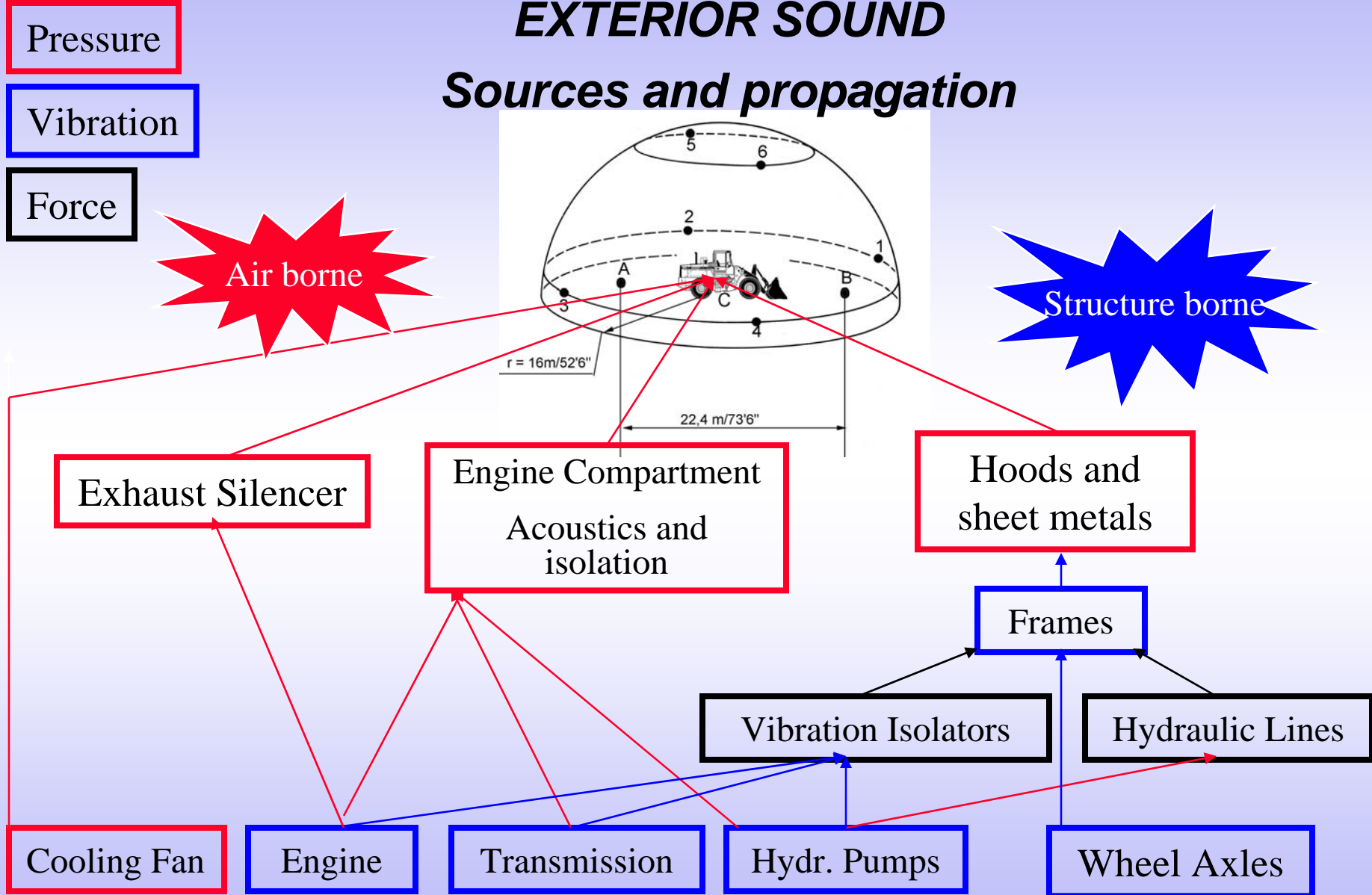
Low Sound and  
Vibration Levels

### Tyres

Low Vibration Levels

## EXTERIOR SOUND

### Sources and propagation



## Exterior Sound Volvo CE

### Legislation

- Directive 2000/14/EU:

#### **Stage I from 3 January 2002**

$$L_w = 85 + 11 \times \log P^*) \text{ (WLO,ART,GRD,COE)}$$

$$L_w = 84 + 11 \times \log P^*) \text{ (EXC)}$$

#### **Stage II from 3 January 2006**

$$L_w = 82 + 11 \times \log P^*) \text{ (WLO,ART,GRD,COE)}$$

$$L_w = 81 + 11 \times \log P^*) \text{ (EXC)}$$

- Vamil (Netherlands):

1 dBA lower than Directive 2000/14/EU stage II

- Bauer Engel (Germany):

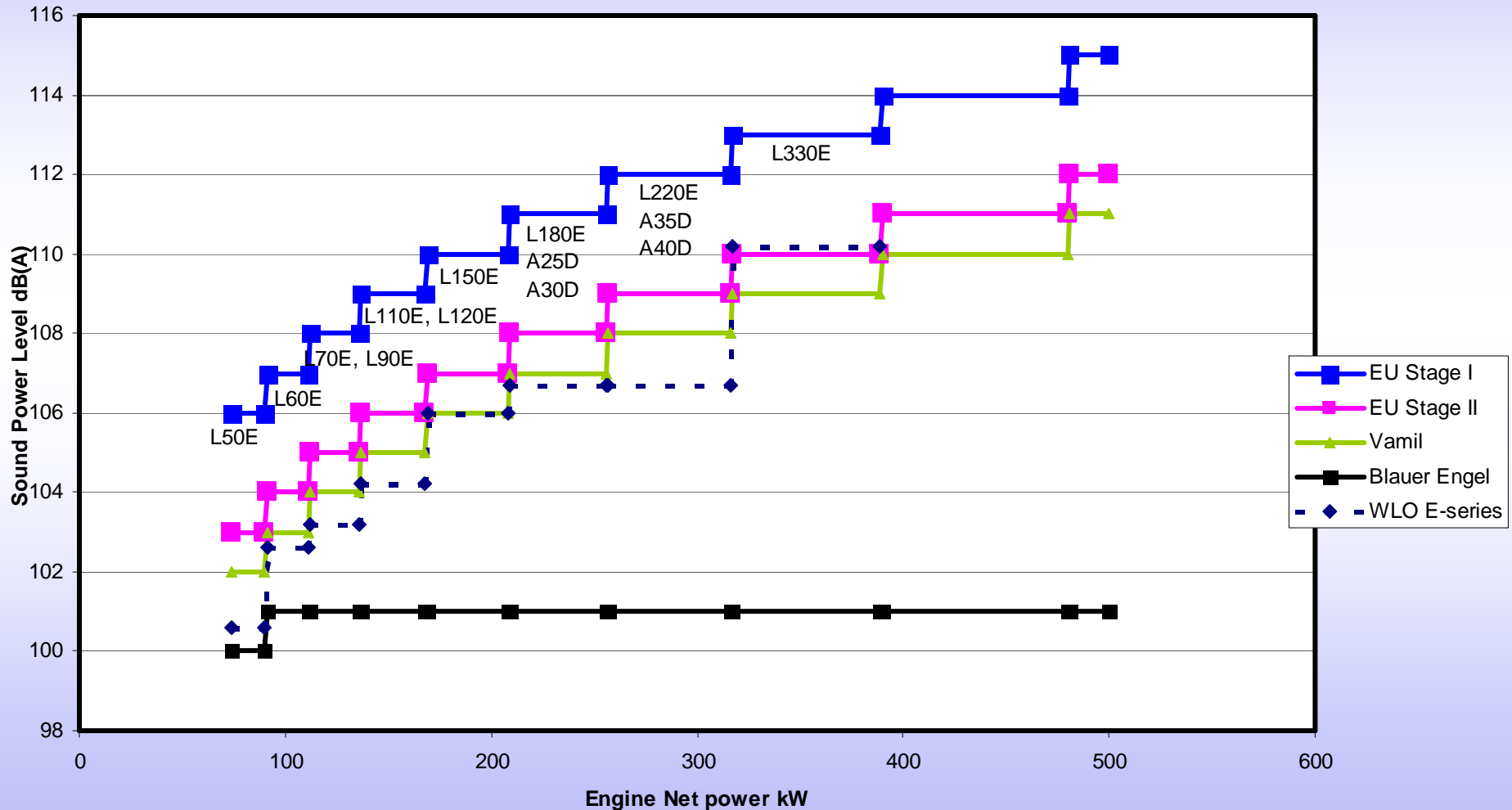
3 dBA lower than Directive 2000/14/EU stage II, max  $L_w = 101$  dBA

<sup>\*)</sup>P = Net engine power in kW

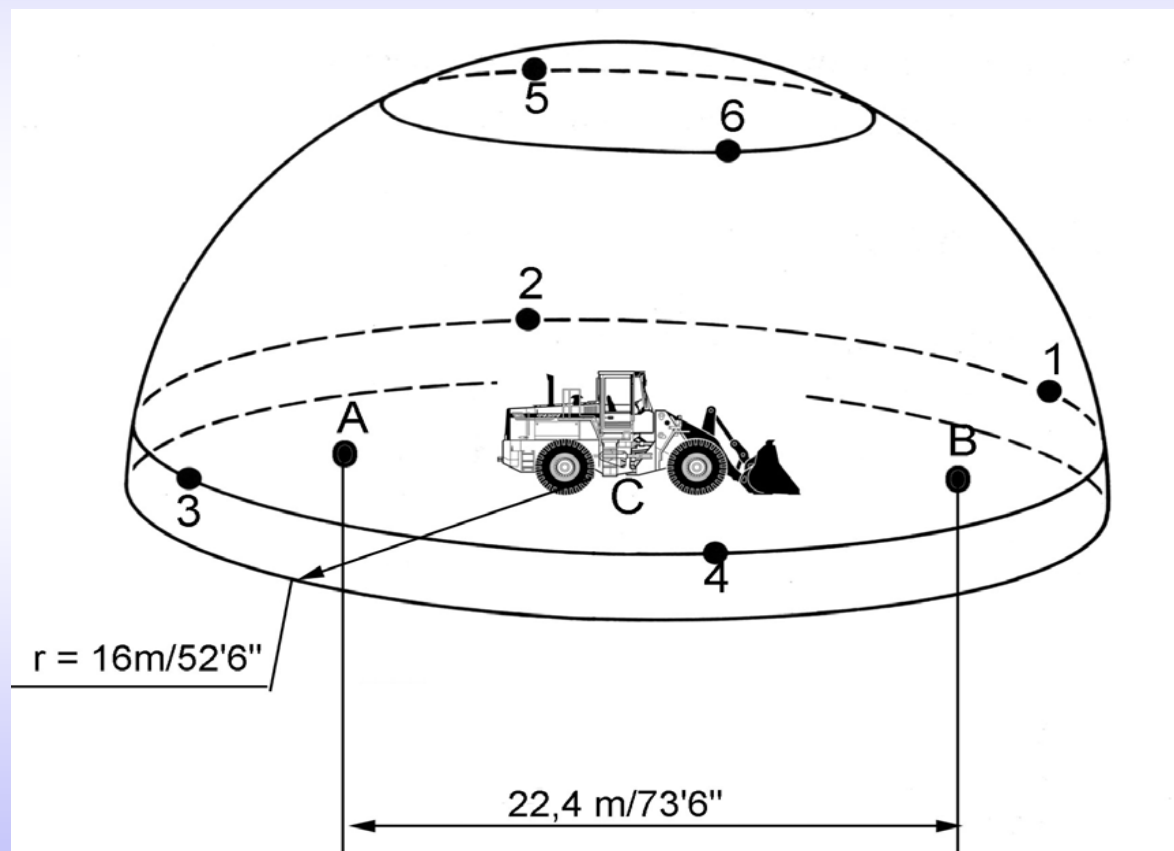


# Exterior Sound Volvo CE

Exterior Sound Demands on Wheel Loaders and Articulated Haulers  
Excavator demand is 1 dBA more stringent



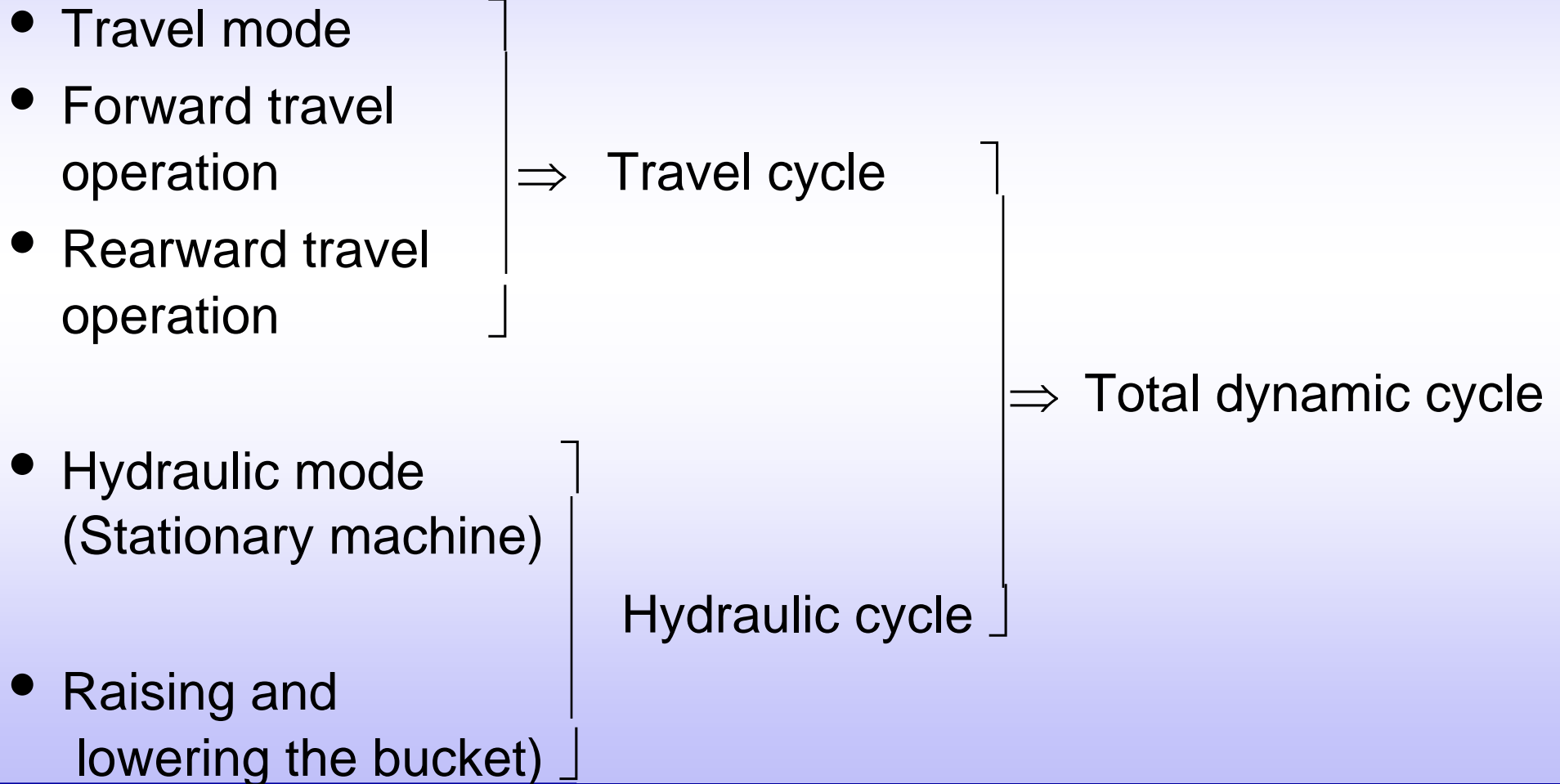
# MICROPHONE ARRAY EXTERIOR SOUND, ISO 6395



# OPERATING CONDITIONS

**Exterior Sound, ISO 6395**

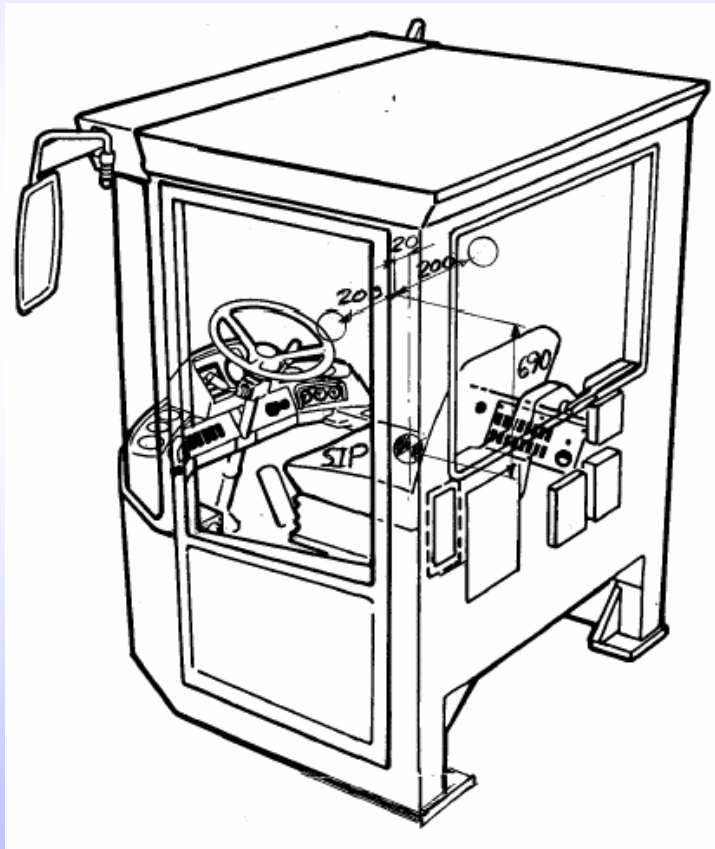
**Interior Sound, ISO 6396**





# MICROPHONE ARRAY

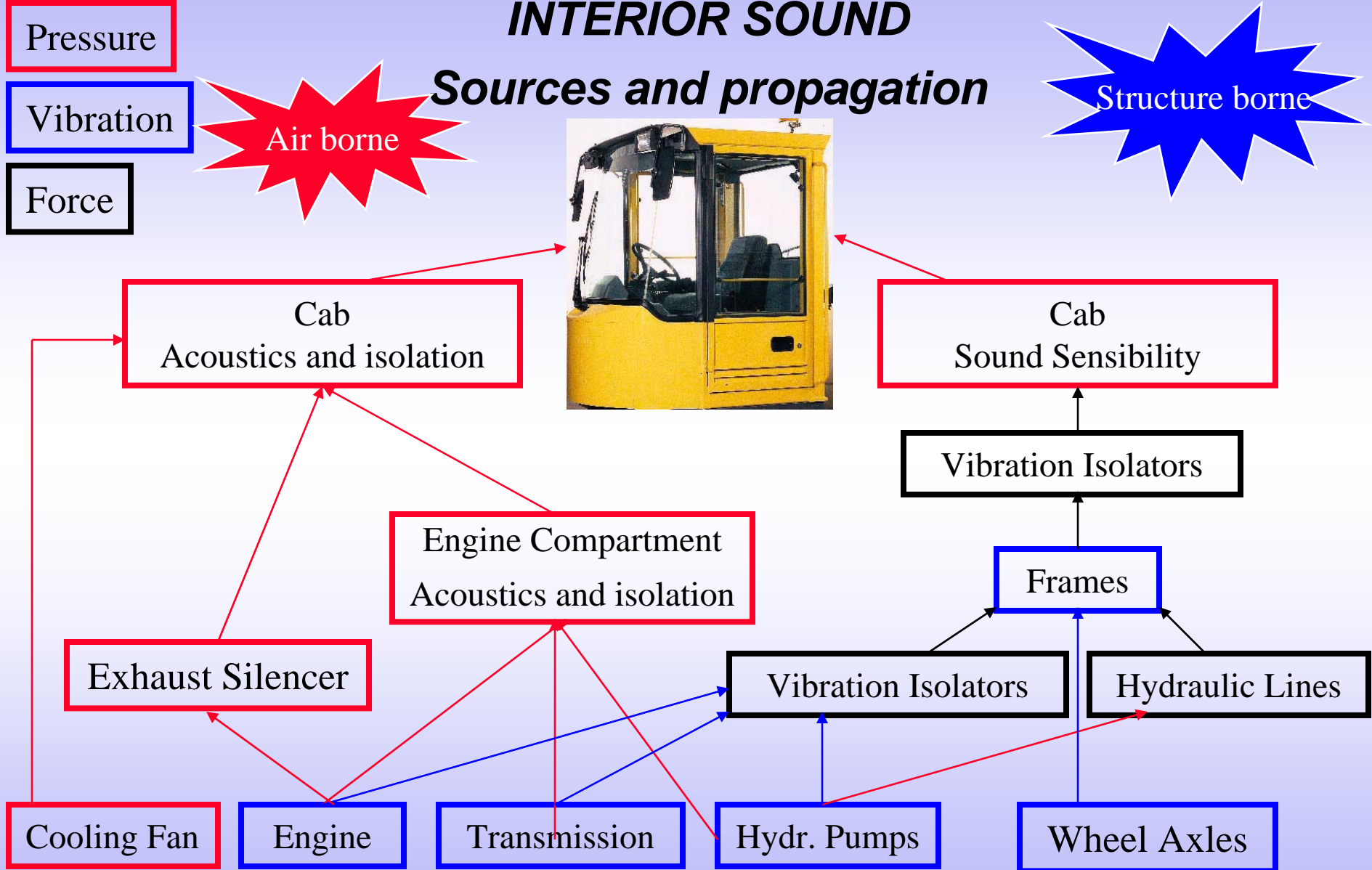
## INTERIOR SOUND, ISO 6396



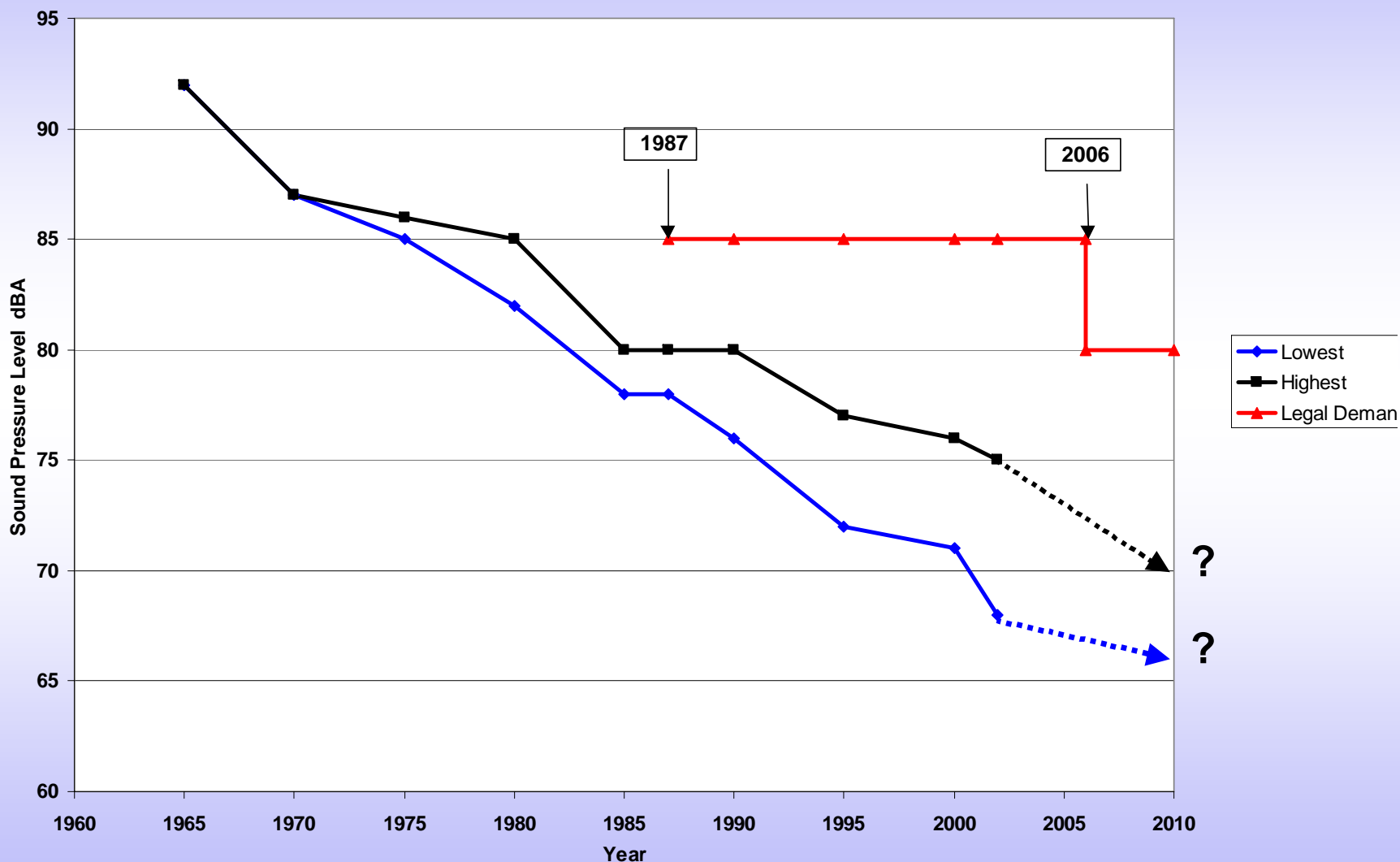
- CLOSED CAB
- VENTILATOR FAN  
INTERMEDIATE SPEED
- MAX ENGINE SPEED =  
HIGH IDLE
- GEAR 1F & 1R
- HYDRAULIC CYCLE

## INTERIOR SOUND

### Sources and propagation

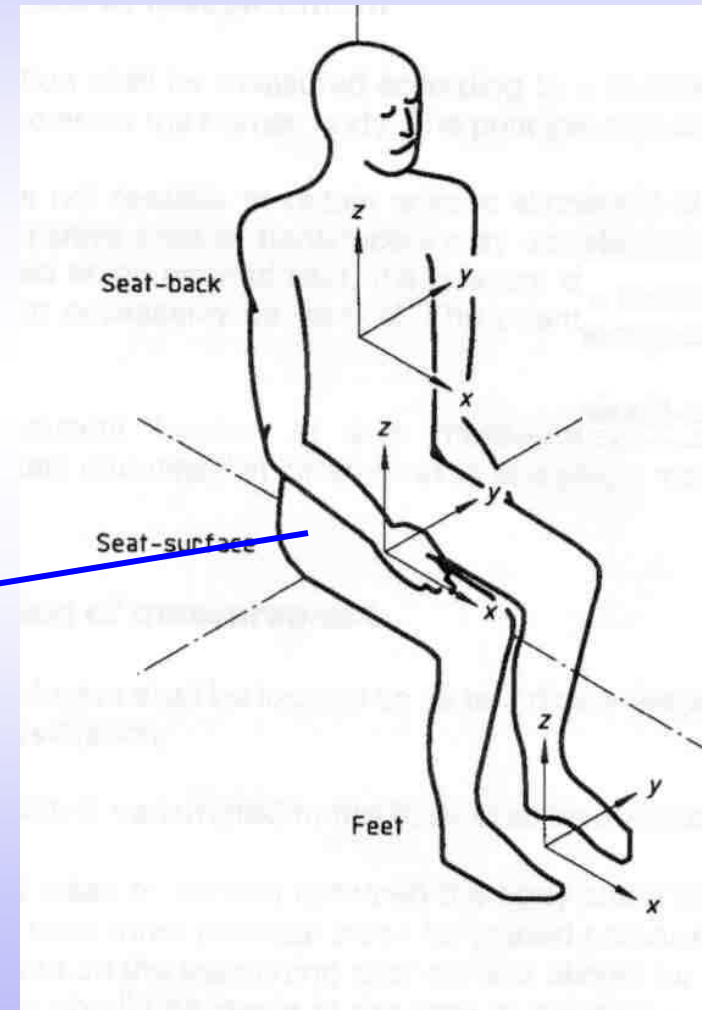


**SOUND PRESSURE LEVEL at OPERATOR'S STATION  
for VOLVO WHEEL LOADERS according to ISO 6396**



## Directive 2002/44/EU, Vibration

- Directive 2002/44/EG will entry into force in Sweden on the 1<sup>st</sup> of July 2005.
- Whole-body vibration
  - **Daily exposure action value:**  $0,5 \text{ m/s}^2$
  - **Daily exposure limit value:**  $1,1 \text{ m/s}^2$
- Test method
  - **ISO 2631**  
Accelerometers (X,Y,Z)  
Mounted on seat cushion  
under the operator



## **Volvo CE**

### **Sound and Vibration Reduction Strategy**

- Demand good sound and vibration characteristics from components
- Design engine / transmission and cab mount arrangement for good sound, vibration and comfort characteristics
- Design frames with low mobility at mounting positions
- Design cab for low sensitivity to structure and air borne sound
- Reserve space for larger mufflers and cooling air paths
- Design engine compartment with improved sound reduction in doors and panels and use sound traps in openings

## **Volvo CE Working Methods**

- Source identification measurements
- Theoretical calculations
- Verification measurements
- Feed back by regular production audits
- Advanced Engineering activities for sub systems
- Cross functional teams
- Establishing engineering guide lines for low noise design
- Sound and vibration network within VOLVO
- Participating in external research projects



# Volvo CE Sound and Vibration

## Sound

- Low noise components
- Hydrostatic fan controlled by cooling demands
- Cooling system separated from engine compartment
- Efficient muffler
- Engine compartment ventilation
  - Exhaust ejector
- Rubber mounted cab and steering valve
- Sound absorbents in ceiling and walls

## Whole Body Vibration

- Boom Suspension

## Sound Legislation in Europe

### **Directive 86/662/ EEC** (Excavators, Dozers, Loader, Backhoes)

- **Stationary test methods (ISO 6393 / ISO 6394) in force from 1st of January 1989**
  - **Exterior Sound Power Levels limited at four levels depending on engine power**
  - **Interior Sound Pressure Level to be labelled**
- **Dynamic test methods (ISO 6395 / ISO 6396) in force from 1st of January 1997**
  - **Exterior Sound Power Levels limited as a function of engine power**
  - **Interior Sound Pressure Level to be labelled**

### **Directive 2000/14/ EC** (Almost all equipment for use outdoors)

- **Dynamic test method (ISO 6395) in force from 3rd of January 2002**
  - **For fans with variable speed, 70% of maximum fan speed allowed at test**
  - **Exterior Sound Power Levels limited as a function of engine power**
  - **Stage I: Same limit values as per January 1997. Guaranteed values.**
  - **Stage II: 3 dBA lower limit values from 3rd of January 2006**